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BOOK REVIEWS.

THE PRIMARY FACTORS OF ORGANIC EVOLUTION. By *E. D. Cope, Ph. D.* Chicago: The Open Court Publishing Co. 1896. Pages, 547. Cuts, 121. Price $2.00.

In the year 1866 there appeared in the *Transactions of the American Philosophical Society* a paper by Professor Cope on the Cyprinoid Fishes. Among the conclusions at which he arrived in this paper were the following: The relation between the generalisation or specialisation of a type and its future progress; the parallelism between ontogenesis and phylogenesis, though he did not use these terms; the results of acceleration and retardation; etc.

The character of the results of this investigation are quoted to show the tendency of thought of the writer. While others were discussing the truth or falsehood of the theory of evolution, or its applicability in special cases, he had turned his attention to the laws of working of the process.

In 1871 in a paper on "The Method of Creation of Organic Types" he propounded a theory of "growth-force" or "bathmism"; and showed how this force, located by effort or use at certain points of the body, produces progressive evolution. Conversely disuse results in degeneration. In this essay we find also the germ, at least, of his later views concerning the importance of consciousness in evolution as the means of directing or locating this use or effort.

These are only the beginnings of a long series of papers which Professor Cope has contributed to the *American Naturalist* and other periodicals during the last thirty years. They are all characterised by the same effort to discover not merely the mode but also the causes of evolution, or more especially of variation.

In 1887 he republished the results of many of these articles in his *Origin of the Fittest.* In this book he strongly opposes the "omnipotence" of natural selection. "Selection," he says, "requires alternatives, and these are the products of "variation. Great obscurity has arisen from the supposition that natural selection "can *originate* anything, and the obscurity has not been lessened by the assertion "often made that these variations are due to inheritance. What is inheritance but "repetition of characters possessed by some (no matter what) ancestor; and if so, "where did that ancestor obtain the peculiarity? The origin of variation is thus "only thrown upon an earlier period."

The present book would seem to have been called forth by the prominence of Weismann's theory, which is diametrically opposed to many of the author's views. It is a discussion of the theories of Preformation and of Epigenesis. "In one of these," he says, "the variations of organisms which constitute progressive and re-"trogressive evolution appear fortuitously, and those which are beneficial survive "by natural selection, while those which are not so, disappear. Characters both "beneficial and useless or harmless, which are acquired by the adult organism, are "transmitted to the young, so that no education in habit or structure acquired by "the adult has any influence in altering the course of evolution. This is the doc-"trine of Preformation. From this point of view the cause of the variations of "organisms has yet to be discovered.

"The other point of view sees in variation the direct result of stimuli from "within or without the organism; and holds that evolution consists of the inheri-"tance of such variations and the survival of the fit through natural selection. "This is the doctrine of Epigenesis. To this I would add that in so far as sensa-"tions or states of consciousness are present, they constitute a factor in the pro-"cess, since they enable an organism to modify or change its stimuli. . . . My aim "will be to show in the first place, that variations of character are the results of "physical causes; and second, that such variations are inherited." (Pp. 13, 14.)

The first chapter of the book treats of variation. Here a large number of cases are adduced to show that "variations are not promiscuous or multifarious, but are of certain definite kinds or in certain directions. (P. 22.) The second chapter containing a little less than one hundred pages, is devoted to phylogeny; twenty-five of these to the more immediate ancestry of man.

This is one of the most interesting, and the most tantalising, of all the chapters of the book. The phylogeny of the classes of vertebrates is discussed in about sixty pages. The phylogenetic charts of the different classes are clear and not confused by unnecessary details. The author is a master of the science of recognising what he can afford to leave out; a science of which most writers seem to be woefully ignorant.

It is interesting to compare this chapter on phylogenesis with Haeckel's *Phylogenie der Wirbelthiere* published a year or more ago. The German scientist gives us a volume of some six hundred large pages. There is no attempt at condensation. The style is delightfully easy and flowing. Paper and ink are abundant and he writes for readers who do not like to be hurried. Wherever the actual ancestor of a line of descent has not yet been discovered, the author reconstructs a hypothetical ancestor. And this hypothetical ancestor "must have existed"; there is no doubt about his existence or characteristics. The connexion and the progressive modifications of the different lines are always clear.

Every new term is carefully explained. The gaps are bridged; the difficult places smoothed and straightened; and we read easily, pleasantly, and without effort. The boundary line between the actual and the hypothetical, between the "is" and the "must be," is not always sharp. But we comfort ourselves with the thought that Professor Haeckel's guesses are very shrewd, and that they have usually been verified by later discoveries.

Our American writer, in his lines of vertebrate phylogenesis, sticks as closely as possible to the facts of palaeontology. The statements are very brief, the anatomical terms are rarely or never explained. New names for great groups of animals are introduced with the briefest definitions possible. The chapter is, it must be confessed, hard reading. And even when we have finished it we are not quite sure as to just what sort of animals, for example, the Cotylosauria were, or how they differed from the Theriodonta. And much the same is true, though in less degree, of the section on the phylogeny of mammals.

The account of the phylogeny of the horse closes with the statements that its "history may be duplicated in manner and mode, by the lines of the camels, the "dogs and bears, the cats, the beaver, etc." And "examination of all these lines "reveals a certain definiteness of end and directness of approach. We discover no "accession of characters which are afterward lost, as would naturally occur as a "result of undirected variation." (P. 149.)

One cannot but feel that the argument of the book would have been strengthened if the author had given us a history of others of these narrower lines of mammalian development, even at the expense of leaving out the discussion of vertebrates in general.

For in this chapter the author seems to the ordinary mind to have undertaken the impossible. The chapter should be expanded to a volume, and "writ large" so that all could understand. When we remember how largely the material for mammalian phylogeny has been discovered in America and studied by American palaeontologists; when we notice the striking similarity between many of the charts of Haeckel's *Phylogenie* and those published more than ten years ago in Cope's *Origin of the Fittest;* when we remember further the numerous references to the author's investigations by Professor Zittel in his *Palaeontology;* we feel that we have a just claim on the author of this book for a work on Vertebrate Phylogeny, and that "t'were well 'twere done quickly."

The third chapter discusses the parallelism between ontogeny and phylogeny, and the fourth chapter treats of Katagenesis or degeneration. Here the relation between degeneration and akinetogenesis, or lack of use or effort, is well presented.

In the second part of the work the author treats of the Causes of Variation. He says "I propose to cite examples of the direct modifying effect of external in"fluences on the characters of individual animals and plants. These influences "fall naturally into two classes, viz., the physico-chemical (molecular), and the "mechanical (molar). The modifications so presented are supposed to be the re"sult of the action of the causes in question continued throughout geologic time.

"To the two types of influence which thus express themselves in evolution, I have "given the names Physiogenesis and Kinetogenesis."

The chapter on physiogenesis contains a very interesting series of observations of the effect of light and color on animal coloration. But the chapter might well have been longer. The author has selected rather too sparingly from the wealth of illustrations which he had at his command.

Chapter VI. treats of Kinetogenesis or the effects of use and disuse. This is the longest and, all in all, the most interesting chapter in the book. The author discusses the shells of mollusks, the effects of use on muscles, the results of impacts and strains on bones, the origin of dental structures, and other important subjects. The argument is clear, strong, and convincing. The chapter contains also an admirable account of the origin of osseous vertebrae.

The third part of the volume treats of the inheritance of variation. In the chapter on Heredity the hypothesis concerning the mode of inheritance of acquired characteristics is stated with remarkable clearness and precision. The author says: "The effects of use and disuse are two-fold, viz.: the effect on the soma, and the "effect on the germ-plasma. Those who sustain the view that acquired character-"istics are inherited, must, I believe, understand it as thus stated. The character "must be potentially acquired by the germ-plasma as well as actually by the soma. "Those who insist that acquired characters are not inherited forget that the char-"acter acquired by the soma is identical with that acquired by the germ-plasma, "so that the character acquired by the former is inherited, but not directly. It is "acquired contemporaneously by the germ-plasma, and inherited from it. There "is then truth in the two apparently opposed positions, and they appear to me to "be harmonised by the doctrine above laid down, which I have called the Theory "of Diplogenesis, in allusion to the double destination of the effects of use and dis-"use in inheritance." (P. 443.)

The whole chapter is so full of facts, thought, and suggestion that no one quotation can do it justice. But some of the evidence adduced for the inheritance of acquired characters seems decidedly weak.

The chapter on the Energy of Evolution is especially interesting for its logical tendency. The author divides the energies manifested by living beings into those which "tend away from, and those which tend toward, the phenomena of life." The latter or anagenetic class is exclusively vital, and tends to upward progress, in the organic sense, that is toward the increasing control of its environment by the organism. The former class, composed of the catagenetic energies, is physical and chemical. "The catagenetic energies tend to the creation of a stable equilibrium "of matter, in which molar motion is not produced from within, and sensation is "impossible. In popular language, the one class of energies tends to life; the "other to death." (P. 475.) In another passage he says, "I have given to that "energy which is displayed by the plant in the elaboration of living from non-living "matter the name of antichemism."

The discussion of this apparent "dualism" is exceedingly suggestive, but it is too long to give in full, and mere quotations would only do it injustice.

One great merit of the author's writings is that, while he never undervalues the importance of mechanical processes in evolution, he always emphasises the importance of mind. The Function of Consciousness is well treated in the tenth chapter. "Consciousness was coincident with the dawn of life." "It has pre-"ceded in time and in history the evolution of the greater part of plants and ani-"mals, both unicellular and multicellular. It appears also that, if kinetogenesis "be true, consciousness has been essential to a rising scale of organic evolution." "I think it possible to show that the true definition of life is, *energy directed by* "*sensibility, or by a mechanism which has originated under the direction of sensi-*"*bility.*" (Pp. 508–513.)

Every action was primitively the result of conscious effort and "the mechanism which does the work has developed as the result of the animal's exertions under stimuli."

This is good common sense and sound logic.

We must make just one more quotation: "Why should evolution be progres-"sive in the face of universal catagenesis? No other ground seems discoverable "but the presence of sensation or consciousness, which is, metaphysically speaking, "the protoplasm of mind. The two sensations of hunger and sex have furnished "the stimuli to internal and external activity, and memory, or experience with "natural selection, have been the guides. Mind and body have thus developed "contemporaneously and have mutually reacted. Without the co-operation of all "these factors, anagenesis seems impossible."

The book closes with a brief chapter on the Opinions of Neo-Lamarckians.

It is impossible to give in a brief space an adequate outline of such a book, for the wealth of facts and arguments, of new thoughts and suggestions, has to remain almost unnoticed. Professor Cope is a peculiarly suggestive writer. Old theories are viewed in a new light, are analysed or put in a new or modified form. Scattered all through the book are facts or hypotheses, sometimes bearing only very indirectly on the argument of the chapter, which are full of food for thought.

The chapter on Phylogeny ends with a section on the Law of the Unspecialised, a condensed but very clear presentation of the fact that higher types have always sprung from generalised forms. This law ought to be more widely promulgated in these days of extreme specialisation; for almost every one considers it a "dead letter." But, if true of physical evolution, and our author certainly very nearly demonstrates it, why should it be false in the evolution of the individual mind?

The frequency and importance of small size in progressive lines, especially in mammals, is stated in a single sentence of the same section. Other illustrations are the hypotheses concerning the origin of lungs and of bony vertebrae. The hypothesis concerning the origin of the rhachitomous vertebra, and its illustration are especially worthy of notice in this connexion.

On page four hundred and forty-four sexual reproduction is considered advantageous "on account of its increased opportunity of variation." But is it yet certain that sexual reproduction does not work rather to hinder than to increase variation in the group or species? Does not the intercrossing of forms which have been exposed to different conditions, and which are therefore tending to diverge, result in holding the species as a whole somewhere near a golden mean of structure and progress? Is not one great danger of the intercrossing of closely related forms to be found in the fact that thus individual tendencies of variation are enhanced until they are abnormal and injurious? Indeed, does not nature, so to speak, have to keep a brake on the too rapid variation of the central, ascending phylogenetic line leading toward man, lest too many of its members rapidly become specialised and thus unproductive of anything higher? There are doubtless other, perhaps even more effective, hindrances to specialisation; but does not sexual reproduction work with these rather than against them? This, if we remember rightly, is Hatschek's view; but we may do him injustice.

The whole book is a marvel of condensation. It is a storehouse of facts, arguments, and suggestions; but it is so condensed that it is not easy reading. It is very pleasant to come across a scientific article or book where the chaff has been carefully removed. They are exceedingly rare, but even the virtue of condensation may be exaggerated into a fault. One must read it chapter by chapter. Like some condensed foods, it requires good powers of digestion in the user.

It is moreover the work of a thorough palaeontologist as well as profound student of comparative anatomy. Hence it has a special place and value.

But Weismann is a very skilful and wary antagonist, and seems to have a defence for every attack. If the palaeontologist can show that variation is really linear, Weismann's theory is disproved. And Professor Cope has given us lines of mammalian evolution, for example, traced out with great clearness; and they are proven with a vast amount of acumen, skill, and patient observation. It is dangerous to try to imagine just what a follower of Weismann would say about any subject for the theory is not only complex but also protean; it changes front to every new attack. But might he not make the following objection with some justice? Of all the formerly existing individuals of a series of species of vertebrates the palaeontologist has but few specimens and these collected from a comparatively narrow area. His material is too scanty to give him any adequate conception of the amount of variation of which the species at any one stage was capable. When more material has been collected the variation of any species at each stage may yet prove to be fortuitous. The forms which survive through successive periods of time, or through a series of stages of evolution naturally form more or less straight lines of variation, for these lines are favored by natural selection. But this linear survival is entirely compatible with a fortuitous variation. Is it not at present an almost necessary result of the character of the two fields of study that the zoölogist should have the advantage in the study of variation, and the palaeontologist in the study of survival and hence of phylogeny ? And that parallel lines of survival should be fostered in different groups by natural selection from fortuitous variation need not surprise us.

This objection may not apply to inferences drawn from the teeth of mammals for here the palaeontologist may have vastly more material than we have supposed. And the most devoted follower of Weismann must feel surprise that the lines of survival are so straight and with so few branches. We cannot fail to notice how largely the palaeontologists are Neo-Lamarckians.

In the emphasis placed on consciousness, will, and effort, this volume is a most valuable and timely contribution. Students of evolution have too generally represented not only vital processes but even life itself as almost or quite purely mechanical, molecular, or chemical. Hence they have either neglected or slurred all its mental aspects. They have sought the living among the dead until they forget what life is and what are its chief characteristics. For supremacy of mind over material, and finally over itself, is the evident goal of evolution. All such purely mechanical or chemical theories, when applied to human progress, necessarily proved misleading or useless.

But when life is defined as "energy directed by sensibility," each of its aspects has received its due emphasis. Well may the author claim that "from this point of view the study of the evolution of mind and its relation to the organic world assumes a new importance."

Now and then the book reminds us of the writings of the Apostle Paul; "in which are some things hard to be understood, which they that are unlearned wrest unto their own destruction." Bathmism we can remember, and its meaning also. But what of Statogenesis, Emphytogenesis, Autobathmogeny, Mnemogenesis, and Cryptopnoÿ? If even Mephistopheles had seen these and sundry other compounds which occur in the volume, he could hardly have found it in his heart to urge an unsuspecting student to "learn words."

Any one who will read this book carefully and thoughtfully cannot fail to have a new, and clearer, and more just, conception of the factors and the process of evolution; and will find his mind continually stimulated to think along new lines.

JOHN M. TYLER.

OSTWALD'S KLASSIKER DER EXAKTEN WISSENSCHAFTEN. A Serial Publication, at Present Embracing More than Eighty Works in Mathematics, Physics, Astronomy, Chemistry, Crystallography, Botany, and Physiology. Edited by Prof. Dr. *Arthur von Oettingen*. Leipsic: Wilhelm Engelmann.

The impression is a widespread one in the popular mind that novelty in science, like novelty in the practical arts, constitutes by the very fact and virtue of its novelty an advance upon the old, supplanting and undoing it. The popular mind,